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THE FAUNA OF THE CHAZY LIMESTONE

By Percy E. Raymond

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Art. XXXVIII.—*The Fauna of the Chazy Limestone*;[*] by Percy E. Raymond.

Introduction.

In several papers on the Chazy limestone, Brainerd and Seely have given sections showing the lithological characters and thickness of the rocks at various localities from Chazy, New York, south to Orwell, Vermont.[†] These authors have divided the formation into three parts, A, B, and C, of which A is the base and C the top. These divisions are founded partly on lithologic and partly on paleontologic grounds. Only a few species of fossils, however, were listed; hence it has been the object of the present writer to ascertain which are the common species in the Chazy, and to learn their stratigraphic and geographic distribution. For this purpose, detailed sections have been made at Crown Point, Valcour Island, and Chazy, and extensive collections have been obtained at other places in the Champlain and Ottawa valleys. The sections will be fully described in the Annals of the Carnegie Museum. In this place, however, only a synopsis of each is given.

Distribution.

The Chazy formation was named by Ebenezer Emmons[‡] from the outcrops studied by him at Chazy village, New York, this locality, therefore, becoming the typical one for the formation.

In stratigraphic position, the Chazy overlies the Beekmantown (Calciferous) and underlies the Lowville (Birdseye) member of the Mohawkian. It may be traced from Orwell, Vermont (along the Champlain Valley), to Joliette, north of Montreal, Canada. In the Ottawa Valley, it extends from Hawksbury west to Allumette Island, 80 miles northwest of Ottawa. The formation is seen again at the Mingan Islands in the St. Lawrence, where it covers a small area.

In the Lake Champlain region, these strata are mostly limestone, and the thickness ranges from 60 feet at Orwell to 890

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[*] Abstract of part of a thesis presented to the Faculty of the Yale University Graduate School for the degree of Doctor of Philosophy. The detailed paper, with full discussion and illustration of species, will be published in early numbers of the Annals of the Carnegie Museum. For description of the trilobites here mentioned, see Annals of the Carnegie Museum, vol. iii, p. 328, and this Journal, vol. xix, p. 377. Other new forms noted in the text are described at the end of the present paper.

[†] Amer. Geol., vol. ii, p. 323, 1888; Bull. Geol. Soc. Amer., vol. ii, p. 300, 1891; Bull. Amer. Mus. Nat. Hist., vol. viii, p. 305, 1896.

[‡] Geology of New York, Pt. 2, Report of the Second District, 1842, p. 107.

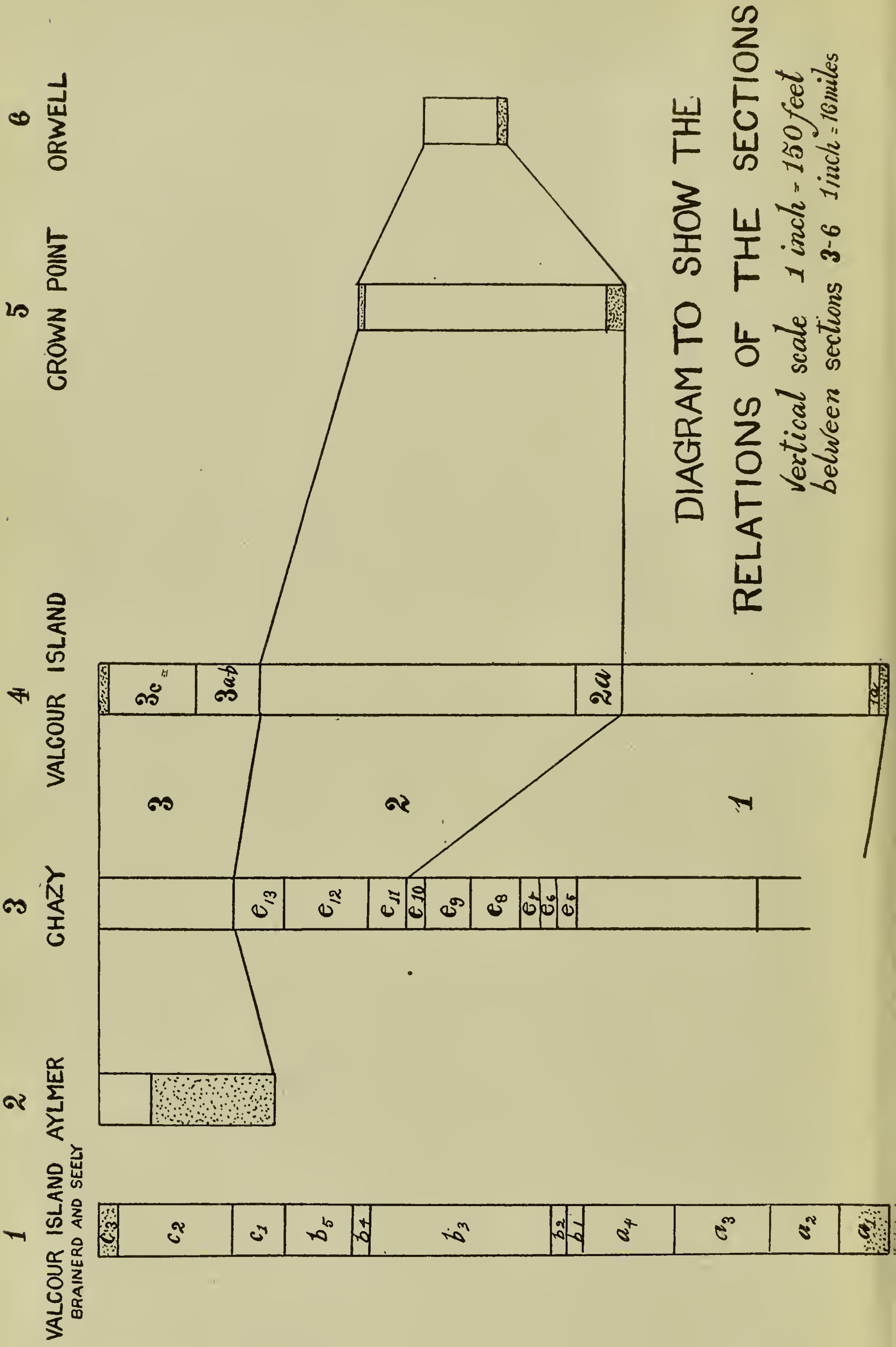

DIAGRAM TO SHOW THE RELATIONS OF THE SECTIONS

Vertical scale 1 inch - 150 feet
between sections 3-6 1 inch = 16 miles

feet at Valcour Island. Further north the thickness is not definitely known. In the Ottawa Valley, the formation is usually from 100 to 200 feet thick and is about half limestone and half sandstone, the former usually overlying the latter. At the Mingan Islands, the thickness was estimated by Sir William Logan at about 300 feet, and the strata include both shales and limestone.

LAKE CHAMPLAIN REGION.

As the typical Chazy is exposed in the Lake Champlain region, that area will be first taken up. In general, the Chazy rocks are seen as a narrow belt running almost north and south from Orwell, Vermont, to Joliette, Canada. The area is seldom more than 10 miles wide, and is not a continuous exposure, but occurs in small patches, in most cases evidently fault blocks, and the strata are usually inclined at a considerable angle. The principal outcrops are along the west side of Lake Champlain and on the islands in the northern part of the lake. South of Willsboro Point, there are scattered patches on both sides of the lake nearly to Fort Ticonderoga.

Faunal Divisions.

In the Lake Champlain region, three major faunal divisions of the Chazy may be distinguished. Within these, there are again various zones which are more or less local in geographical extent.

Division 1. The Hebertella exfoliata Division.—The strata of this basal division are chiefly light-colored, impure, rather coarse-grained limestones and frequently have shaly partings. The thickness varies from nothing at the south end of Lake Champlain to 300 feet on Valcour Island, 365+ at Chazy, and 225 feet on Isle La Motte.

The characteristic fossils are: *Hebertella exfoliata* sp. nov., *Orthis acutiplicata* sp. nov., *Strophomena prisca* sp. nov., *Scenella pretensa* sp. nov., *S. montrealensis*, *Palæacmæa irregularis* sp. nov., *Raphistoma immatura*, and *Scalites angulatus.* Other species occurring abundantly in this zone are: *Blastoidocrinus carchariædens*, *Bolboporites americanus*, *Zygospira acutirostris*, *Raphistoma stamineum*, *Lophospira subabbreviata*, *Bucania sulcatina*, and *Pseudosphærexochus chazyensis.* Those which occur only rarely in this division, but which thus far have not been found in higher divisions, are: *Lingula belli*, *Cyrtodonta solitaria* sp. nov., *Cyclonema? normaliana* sp. nov., *Eunema leptonotum* sp. nov., and *Heliomera sol.*

Of the 141 species in the Chazy whose range is known, 64 make their first appearance in this horizon and 23 are found in all three divisions. This member is further marked by the appearance of the earliest of American Bryozoa, and these, unlike most Ordovician species, range throughout the entire formation above the sandstone.

Division 1 is characterized by the predominance of individuals and species of Brachiopoda. Fourteen of the 25 species of this group occurring in the Chazy of the Champlain Valley are found in this lowest member, while only 2 of the 16 pelecypods are represented. Exactly half the species of trilobites are also found here, but specimens are not common. Gastropods are more numerous, as half the species are represented and individuals of some forms are abundant. They do not occur in the lower strata, but are confined almost entirely to the upper part.

There are three zones in this division which are worthy of notice:—

Zone 1_a, or the *Orthis acutiplicata* zone, is near the base of the division and is found at Valcour Island and Isle La Motte. The characteristic fossils are: *Orthis acutiplicata*, *Rafinesquina incrassata*, *Isotelus harrisi*, and *Thaleops ovata*, all long rangers except the first.

Zone 1_b. The *Scalites angulatus* zone. The faunule of this zone is found at Plattsburg and Chazy. It is located near the middle of Division 1. The characteristic fossils are: *Scalites angulatus*, *Raphistoma immaturum*, *R. stamineum*, *Bucania sulcatina*, *Camarella longirostris*, *Illænus globosus*, and *Thaleops ovata*. Only the first two are restricted to this horizon.

Zone 1_c, the *Lophospira subabbreviata* zone, has been found only at Chazy, but is very strongly marked. It occurs about 75 feet below the top of Division 1. The characteristic fossils are: *Lophospira subabbreviata* and *Raphistoma stamineum*, both of which are very abundant. Of less importance are the rare *Schizambon? duplicimuriatus*, *Heliomera sol*, and *Clionychia marginalis* sp. nov.

Division 2. The Maclurites magna Division.—The strata of this middle division are usually heavy bedded, dark blue and grey, fairly pure limestones, with an occasional layer of grey sparkling dolomite or of light coarse-grained limestone. The layers near the middle usually weather into nodular masses, and the fossils are frequently poorly preserved and difficult to extract. The thickness varies from 200 feet at Chazy to 400 at Valcour Island, and decreases toward the south. The characteristic fossils are: *Maclurites magna*, *Rafinesquina champlainensis*, *Plæsiomys platys*, *P. strophomenoides* sp. nov., *Strephochetus*, *Eospongia varians*, *Eotomaria obsoletum* sp. nov., *Eccyliopterus fredericus*, *Bathyurellus minor*, *Glaphurus primus*, and *Leperditia limatula* sp. nov.

Thus far, the following fossils have been found only in this division, and most of them in but one locality: *Camarotœchia pristina* sp. nov., *Ctenodonta dubiaformis* sp. nov., *Clidophorus obscurus* sp. nov., *Cyrtodonta expansa* sp. nov., *Endodesma undulatum* sp. nov., *Scenella robusta* sp. nov., *Raphistoma undulatum* sp. nov., *Helicotoma vagrans* sp. nov., *Bucania bidorsata?*, *Trochonema dispar* sp. nov., *Subulites prolongata* sp. nov., *Holopea scrutator* sp. nov., *Eoharpes ottawäensis*, *Asaphus marginalis*, *Isotelus angusticauda*, *Isotelus? bearsi*, *Illænus punctatus*, *Cybele valcourensis*, *Ceraurus pompilius*, *C. hudsoni*, and *Pseudosphærexochus approximus*.

This middle division is marked by an abundance of pelecypods, gastropods, and trilobites, and in this respect is sharply contrasted with the lower division. Of the 16 pelecypods, 13 are represented here. Of 35 trilobites, 27 are present.

Species of *Stromatocerium* and *Strephochetus* are common in these rocks, but are also abundant in the lower zone of the next division.

Zone 2_a. The *Malocystites murchisoni* zone. Thus far, only one subfaunule has been detected in Division 2, and that is at the very base. It is best developed at Valcour, but occurs also on Valcour Island. The zone is characterized by the great abundance of cystid fragments. The characteristic fossils are: *Glaphurus primus*, *Eoharpes antiquatus*, *Lonchodomas halli*, *Cybele valcourensis*, *Malocystites murchisoni*, *M. emmonsi*, *Glyptocystites forbesi*, *Palæocystites tenuiradiatus*, *Raphistoma stamineum*, *Maclurites magna*, *Plæsiomys strophomenoides*, and *Camarella varians*.

Division 3. The Camarotœchia plena Division.—The strata of this division are rather thin bedded, light grey, coarse-grained limestones, abounding in fossils. Near the base there are always buff-colored, pure, fine-grained dolomites and heavy bedded, coarse-grained blue limestones. The only fossil which is found throughout this division is *Camarotœchia plena*. Other characteristic fossils are: *Camarotœchia major* sp. nov., *Orthis ignicula* sp. nov., *Modiolopsis fabaformis* sp. nov., and *Glaphurus pustulatus*.

There is here a decided falling off in the number of gastropods and pelecypods, only 6 of the former and 5 of the latter being represented. There are about as many trilobites (16) in this division as in Division 1, and 8 of these are found in all three sections. The number of species of brachiopods is about the same in each of the three divisions, but they dominate the fauna in the first and third. In the former, one of the Protremata (*Hebertella*) is most abundant, while in the third division one of the Telotremata (*Camarotœchia*) predominates.

There are three well-marked zones in this division, as follows:

Zone 3_a, the *Glaphurus pustulatus* zone, is found at the base of Division 3, at Valcour Island, Chazy, Cooperville, and Isle La Motte. The characteristic fossils are: *Glaphurus pustulatus*, *Illænus globosus*, *I. erastusi*, *Isotelus harrisi*, *Remopleurides canadensis*, *Pliomerops canadensis*, *Amphilichas minganensis*, *Pseudosphærexochus vulcanus*, *Camarotœchia plena*, *Conocardium beecheri* sp. nov., *Bucania sulcatina*, and several cephalopods.

Zone 3_b, the *Camarotœchia major* zone, stands between 3_a and 3_c and its faunule is a transition between the two. *Camarotœchia* becomes more abundant and better developed, and fossils, while numerous, become fewer in species. The best development is at Valcour Island. The characteristic fossils are: *Camarotœchia plena*, *C. major*, *Hebertella costalis*, *Malocystites emmonsi*, *Malocystites* sp., *Palæocystites* sp., *Illænus globosus*, *Pliomerops canadensis*, *Bucania sulcatina*, *Raphistoma stamineum*, and *Isotelus obtusum*.

Zone 3_c. The *Modiolopsis fabaformis* zone. In this zone, *Camarotœchia plena* is abundant, almost to the exclusion of other species. The faunule extends to the top of the formation at Chazy, Grand Isle, and Valcour Island. The characteristic fossils are: *Camarotœchia plena* and *Modiolopsis fabaformis*.

Section at Chazy, New York.

The section at Chazy has a thickness of 732 feet, but the base of the formation is not shown.

Division 1.—The rocks carrying the fauna of Division 1 are well exposed in the ridges south of the village, near Tracy Brook. The thickness is 365 feet, and judging from the fauna at the base, at least 150 feet of strata are missing. *Hebertella exfoliata* is very abundant, especially below the horizon of *Scalites angulatus*. The latter zone is 217 feet above the base of the exposed section, and is zone 1_b of the generalized section. The most common fossils are: *Scalites angulatus*, *Bucania sulcatina*, *Raphistoma immaturum*, *R. stamineum*, and *Thaleops ovata*. Higher up in the section, 275 feet above the base, is the zone of *Lophospira subabbreviata*, about 35 feet in thickness. This is zone 1_c of the generalized section. The gastropods are very abundant in the three localities at Chazy where this zone is exposed.

Division 2.—The strata of this division are about 195 feet in thickness, and are dark blue, impure nodular limestones, usually full of fossils which are frequently silicified. *Stroma-*

tocerium, *Eospongia varians*, *Rafinesquina champlainensis*, *Plæsiomys platys*, *Maclurites magna*, *Pliomerops canadensis*, and several cephalopods are common.

Division 3.—The *Camarotœchia plena* division is not very well developed along the line of the section at Chazy. The thickness is 156 feet, but a large part of the strata is covered with soil. At the base are about 25 feet of grey dolomite with almost no fossils. The remainder of the rock, as far as exposed, is an impure shaly limestone, abounding in *Camarotœchia plena*. Zones 3_a, 3_b, and 3_c can not be distinguished just at Chazy village, probably because the strata are so poorly exposed. About 3 miles southeast of this point, however, in a field near the lake shore, fine outcrops of zone 3_a occur, and here *Glaphurus pustulatus*, *Amphilichas minganensis*, *Illænus globosus*, and the cephalopods are common.

Section at Valcour Island.

On Valcour Island, the whole of the Chazy is exposed, with a thickness of 890 feet. In one section along the south end, almost the entire thickness is shown, while nearly all the missing parts may be seen in other sections on the east and north sides of the island.

Division 1.—The strata of this division are well exposed on the south end. The thickness is 314 feet. At the base is a zone of sandstone and shale in which *Lingula brainerdi* is the common fossil. Other fossils are rare, *Isotelus harrisi* and a species of *Eccyliopterus* being the only ones thus far found. Above this zone is that of *Orthis acutiplicata*, 10 feet in thickness.

The *Scalites angulatus* zone is not exposed on Valcour Island, the rocks usually containing it being absent at the pebble beach on the south end of the island. The *Lophospira subabbreviata* zone is not well developed, but may be indicated by a fauna found on the middle of the west side.

Division 2.—The strata of this division are 406 feet in thickness and are usually compact, dark blue and grey limestones. The fossils are frequently coarsely silicified, but are almost always difficult to extract. At the base, zone 2_a, the *Malocystites murchisoni* zone, is well developed, and as the fossils weather out in this locality, some 40 species have been listed.

While the rocks of this division usually afford poor collections, yet in favorable localities they are found to be extremely rich in interesting species. Thus, one locality on the east side of the island has yielded 60 species of fossils, among them such rare trilobites as *Asaphus marginalis*, *Isotelus ? bearsi*, and *Remopleurides canadensis*, and many species of pelecypods.

Division 3.—This is especially well developed on Valcour Island. Zone 3_a is exposed in two or three localities on the east side. Zone 3_b is best developed about Cystid Point, the southeast point of Valcour Island, and zone 3_c is exposed both east and west of Black River Point on the north end. The division is 172 feet in thickness and carries *Camarotœchia plena* throughout. The faunules given for zones 3_a, 3_b, and 3_c, are those found on Valcour Island.

*Crown Point Section.**

The section at Crown Point is 305 feet in thickness. At the base is a zone 25 feet thick in which the strata are sandstone and shale, and the only fossil is *Lingula brainerdi.* The remaining 280 feet are impure blue and grey limestone, usually very fossiliferous. Division 1 is absent.

Division 2.—The fauna characteristic of this division is found all through the section at Crown Point. The characteristic fossils—*Maclurites magna*, *Rafinesquina champlainensis*, *Plæsiomys platys*, and *Leperditia limatula*—are very abundant, and the whole expression of the fauna is that of the middle part of the section at Valcour Island and elsewhere. Brainerd and Seely assign the lower 48 feet to their Division A, and the upper 57 feet to Division C, but faunally the whole section belongs together. *Camarotœchia plena* is absent, as are also the other fossils characteristic of Division 3. The upper 3 feet of the section are a coarse limy sandstone, with *Plæsiomys platys*, *Camarella varians*, *Raphistoma stamineum*, and *Isotelus harrisi* in a layer a foot thick at the top.

Orwell, Vermont.

A short distance northeast of Orwell village is the most southern exposure of the Chazy. At that place there are about 60 feet of strata, the fauna of which indicates that they belong to Division 2. Another locality near by shows sandstone and shale at the base of the formation.

North of the International Boundary the various divisions can not be followed in the published lists, but this is due to the fact that no sections have been made in that region. The lists published by Billings, Logan, and Ami, of the Canadian Survey, however, do show that fossils characteristic of all three divisions are found in that region. The Champlain Valley fauna of the Chazy, which will be designated as the typical one, is found as far north as Joliette, 35 miles north of Montreal and

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* For detailed description of this section, see Bull. Amer. Pal., vol. iii, No. 14, 1902.

85 miles north of Chazy. To the west it is found as far as Hawkesbury, 75 miles northwest of Chazy and 55 miles west of Montreal.

MINGAN ISLANDS REGION.

The fauna of the Chazy at Mingan Islands is very closely related to that of the typical Chazy of the Champlain Valley, as is shown by the following list of species common to the two regions:—

Bolboporites americanus.
Phylloporina incepta.
Columnaria ? ? parva.
Rafinesquina incrassata.
Camarotœchia orientalis.
Camarella longirostris.
C. varians.
Orthoceras bilineatum.
O. multicameratum.
Pieisoceras jason.
Pliomerops canadensis.
Illænus globosus.
Eoharpes antiquatus.

OTTAWA VALLEY REGION.

The Chazy deposits of this region have been described in detail by Logan,[*] Ells,[†] and Ami.[‡] The formation is not more than 200 feet in thickness, usually less, and is divided into two parts, the lower including shales and sandstones, and the upper, limestones. It outcrops in a narrow belt extending along the north and south sides of the Ottawa River, from Hawkesbury west to Arnprior, and is again exposed south of Ottawa, whence another narrow belt runs to Cornwall, where it again turns northward. West of Arnprior there are a few outliers of the same formation. One large one occurs at Allumette Island, north of Pembroke, and another 10 or 15 miles south of this and west of Renfrew.

The coarse character of the sediments at the base of the formation in this region points to very shallow water and shore conditions and a probable erosion interval between the end of Beekmantown time and the deposition of the strata of Chazy age.

The writer has studied the rocks of this area chiefly in the vicinity of Ottawa and Aylmer, and the fauna there represented seems to consist of about 25 species, only 7 of which occur in typical Chazy deposits. The fauna of the sandstone at the Aylmer region is quite different from that found in the overlying limestone, and for that reason a list is here given of the species found in each. An asterisk denotes that the species is found also in the typical Chazy:—

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[*] Geology of Canada, 1863.

[†] Rept. Geol. Survey of Canada, 1899.

[‡] Ibidem; also Trans. Roy. Soc. Canada, vol. ii, 1896, vol. vi, 1900, and various other papers.

Sandstone.	Limestone.
Lingula lyelli.	*Lingula lyelli.*
* *Camarotœchia plena.*	* *Camarotœchia plena.*
* *C. orientalis.*	* *Rafinesquina alternata.*
Hebertella imperator.	
Modiolopsis breviuscula.	*Modiolopsis breviuscula.*
M. parviuscula.	*M. parviuscula.*
M. sowteri sp. nov.	
Ctenodonta parvidens sp. nov.	
Whitella canadensis sp. nov.	
* *Archinacella ? deformata.*	
* *Raphistoma striatum.*	
* *R. stamineum.*	*Raphistoma stamineum.*
Lophospira billingsi sp. nov.	*Orthoceras allumettensis.*
Bathyurus angelini.	*Bathyurus angelini.*
Beyrichia clavigera.	*Leperditia amygdalina.*
B. clavigera clavifracta.	* *L. canadensis.*
	Leperditella labellosa.
Primitia sp.	*Isochilina ottawa.*
Isochilina sp.	*I. amiana.*
	Primitia logani.

It may be seen from the above parallel lists that there are only 6 species common to the sandstone and limestone divisions of this formation. In the limestones the ostracods are exceedingly abundant, often making up entire layers of the rock. The two divisions are intimately connected by very well-defined species, however, and none of the forms pass on into the overlying Lowville limestone.

In the Ottawa Valley, the most noticeable feature of the faunas is the absence of the cystids, Bryozoa, and Hydrozoa so common in the typical Chazy. The large number of species of ostracods and their great abundance are in marked contrast to the three or four species found in the Champlain Valley. This difference in the lithology and fauna has led the writer to suggest the name *Aylmer** formation for these deposits in the Ottawa Valley.

Summary on the Lake Champlain, Mingan Islands and Ottawa Valley Regions.

In the Lake Champlain region occurs the fullest development of both the strata and the fauna of the Chazy period, and three divisions based upon faunal differences may be recognized. The fauna of the Chazy at Mingan Islands, while only partly known, shows that the typical Chazy is also found in that region. West of Hawkesbury, Canada, a decided change in the fauna is seen at L'Orignal, only 16 miles from Hawkesbury. Here is found a section less than 200 feet in thickness, with sandstone at the base and limestone in the upper portion. The fauna changes abruptly, several species occurring there which are unknown further east. The typical Chazy fossils found here are: *Camarotœchia plena*, *Raphistoma stamineum*, and *Malocystites murchisoni.* From this locality west to Allumette Island, a distance of 115 miles, the same succession of strata may be found, and about the same fauna. All through the Ottawa Valley the Chazy is represented by a formation which is sandstone at the base and limestone above. In its most western exposures, the limestones are absent and only the sandstone remains.

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* Ann. Carnegie Mus., vol. iii, p. 380, 1905.

The base of the Chazy is always a sandstone, but this does not carry the same fauna in all regions, nor does the zone which rests upon it always have the same fauna. In the Lake Champlain region, the sandstone always contains *Lingula brainerdi;* in the Ottawa Valley, it carries a modified *Camarotœchia plena* fauna. At the type sections, *Lingula brainerdi* is at the base of the formation, while the *Camarotœchia plena* fauna appears 700 feet above.

Since the fullest development of limestone deposits of this age is in the region of Chazy and Valcour Island, New York, that must be the locality in which the Chazy sea persisted longest. From the evidence outlined above, it would seem that this sea was a shallow one, invading south and west over a slowly sinking land. Since the Chazy fauna is apparently developed less directly from the Beekmantown of the Lake Champlain area than from that of Newfoundland, and since there are many European types introduced into the Chazy, it seems probable that this sea was open to the east.

If the sea were thus invading upon the land, the sandstone would represent shore conditions. This is undoubtedly the case, for the sandstone in both the Champlain and Ottawa valleys frequently presents evidences of shore origin in cross bedding, ripple marks, and worm burrows.

If the sea were invading southward in the region now occupied by the Champlain Valley, the sandstone should be younger and younger in age as it is traced from north to south. That this is actually the case is shown by the faunas, for at Valcour Island all the strata of the *Hebertella exfoliata* division, 300 feet in thickness, were deposited before the *Maclurites magna* fauna became prominent, while at Crown Point this second fauna follows immediately upon the basal sandstone.

During the greater part of Chazy time, the transgression is southward, but later the shore began to move westward also. The region of the Ottawa Valley was then invaded, and the sandstone brought with it a part of the *Camarotœchia plena* fauna. The date of this invasion to the west can be rather closely approximated. *Camarotœchia plena*, *Raphistoma stamineum*, and *Malocystites murchisoni* are found in the middle of the section at L'Orignal. At Valcour Island these species occur together in zone A_{39}, 775 feet above the base, thus showing that the formation in the Ottawa Valley represents the very latest part of Chazy time.

Ulrich and Schuchert, in their paper on Paleozoic Seas and Barriers,* bring out this idea of a Chazy sea invading westward and southward. They state: "With the earlier part of this subsidence [the Chazy invasion], the Atlantic invaded the continent westward. . . . The typical Chazy formation . . . bears evidence in its members of having encroached southward and westward in the arms, the latest beds . . . extending farthest south and west."

THE CLOSING PERIOD OF CHAZY TIME.

In the preceding pages an effort has been made to show that in northeastern New York and in the Ottawa Valley, the Chazy sea invaded over a land surface of Beekmantown rocks, and that the base of the Chazy is a tangential sandstone; also that the invasion was first southward, covering the region of the Champlain Valley, and later westward along the locality of the present Ottawa Valley.†

Of the former extent of the formation throughout the St. Lawrence Valley or elsewhere, there is at present little evidence. Since the sea did not attain the region of Aylmer until very late Chazy time, it is probable that the formation never extended much further west than the known outcrops in that region (Allumette Island, etc.).

From a study of the stratigraphy and faunas it becomes evident that the upper portion of the Chazy is not represented in the region south of Valcour Island. Either these beds were never deposited there or they were eroded before the Lowville was laid down. The evidence is not of such a character as to prove definitely which did occur, but for reasons given below it seems more probable that the upper beds were deposited south of Valcour and later eroded. These reasons are as follows:—

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* Rept. N. Y. State Pal., 1902, p. 639.

[† By these terms, Champlain Valley and Ottawa Valley, the writer does not intend to convey the impression that the Chazy deposits were laid down in narrow arms of the sea, or that the topography was then anything like that of the present time. It should be remembered that strata of post-Chazy age are involved in the Green Mountain uplift, and that there are indications that the Adirondacks did not exist in Ordovician time.]

First. All through the Champlain Valley, the Chazy is capped by a bed of sandstone 2 feet in thickness, and this may be interpreted as the invading base of the Lowville formation. From this it would follow that a period of erosion existed between the Chazy and Lowville formations.

Second. If the upper beds were never deposited south of Valcour, the Chazy sea after advancing slowly to the south to some point below Orwell, Vermont, must have then retreated to the northward. Such a recedence could have been caused only by an elevation south of Orwell, for there is no general retreat of the Chazy sea at this time, which is proved by the fact that at a still later period the sea advanced westward beyond Ottawa. That there was then no uplift in the south is shown by the fact that the Lowville sea invades from the southwest.* On the other hypothesis, which seems more probable, the sea would have invaded southward to the region of Orwell and after depositing there the final, or *Camarotœchia plena*, beds vanished from the area of Lake Champlain. During the latter part of Chazy time or after its close, the Stones River (Lowville) sea was invading from south to north and there was a land interval in the Champlain region, during which time some of the Chazy and Beekmantown beds were removed along the barrier region between Orwell and the Mohawk Valley.

Third. By taking the rate of decrease in thickness (11·25 feet per mile) of the *Hebertella exfoliata* division between Chazy and Valcour Island, to compute the probable southern extent of that division, it is seen that it would have reached only 26·6 miles south from Valcour Island. Therefore, at the same rate of decrease the base of the Crown Point section is 461 feet higher than the base of the Valcour Island section. That this rate of decrease can not be used, is shown by the fact that Division 1 at Isle La Motte is only 225 feet thick, which is less than at Valcour Island, while Isle La Motte is as far north as is Chazy. The only reliable data for an estimate of this character are the facts that there are 300 feet of the beds of Division 1 at Valcour Island and nothing at Crown Point. This is a thinning out of 7·3 feet per mile, which, on the other hand, is probably too small. On this basis, the bottom of the Crown Point section is at least 300 feet above the base of the Valcour Island section and the base of the Orwell section is at least 424 feet above it. If this minimum estimate of the height of the base of the Crown Point section above that of the Valcour Island section is accepted as a working basis, it will be seen that the former lacks the upper 285 feet of the formation. This is a gradient of 6·95 feet per mile to the top of the beds at Valcour Island. Taking the base of the Orwell section at 424 feet, the upper 407 feet are lacking. The thinning in the 17 miles from Crown Point to Orwell is 122 feet, or 7·1 feet per mile, while the gradient to the top of the Chazy at Valcour Island is 7·01 feet per mile. The close correspondence of these gradients and the small gradient of 7 feet per mile for 58 miles are significant, and seemingly indicate a base-leveled surface of this land during the Chazy-Lowville interval.

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* See Ulrich and Schuchert.

Representation of Chazy Time in other Regions.

The Chazy was formerly identified by various geologists as covering a large area, but more recently it has been held that while certain formations may have been laid down during Chazy time, the typical rocks and fossils of this period are restricted to the region of the Champlain and Ottawa valleys and the islands in the Gulf of St. Lawrence.

The St. Peter's Sandstone.

One of the formations which has long been correlated in time with the Chazy is the St. Peter's sandstone, which in Iowa, Minnesota, and parts of Illinois underlies the lowest member of the Mohawkian series. The fauna* of this formation is meagre and is contained in a few layers near the top. It is made up chiefly of Mollusca, all closely allied to Trenton forms. None of the species are found in the Chazy; hence no new light is thrown on the correlation by the later studies of the Chazy fauna. On lithological grounds, James has correlated it with the Chazy of the Ottawa Valley, but there are no species common to the two formations. From the close relationship of its fauna to that of the Mohawkian (Trenton) it seems probable that the St. Peter's was deposited during Stones River time.

Stones River Group.

In the Columbia, Tennessee, folio of the U. S. Geologic Atlas, Ulrich has stated that the lower part of the Stones River group, including the Lebanon, Ridley, Pierce, and Murfreesboro limestones, is to be correlated in time with the Chazy of New York State.

This statement is evidently based mainly on stratigraphic grounds, as Ulrich and Schuchert† have held that the Lowville of New York is the northeastern representative of "the extreme top of the Stones River" group.

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* F. W. Sardeson, Bull. Minnesota Acad. Sci., vol. iv, No. 1, pt. 1, p. 64, 1896.

† Paleozoic Seas and Barriers, Rept. N. Y. State Pal.; Bull. 52, N. Y. State Mus., 1902, p. 633.

In the Columbia folio referred to above, Ulrich has tabulated the fossils of all the divisions of the Stones River group as developed in the middle Tennessee region. In the Lebanon formation, the upper member of the Stones River group which is there correlated with the Chazy, there are, according to the table, 37 species besides 10 undescribed Bryozoa. Of these 37 species, 7 are Bryozoa and 5 are not specifically identified. This large number of Bryozoa—17 species—at once suggests that the formation containing them is much more closely allied to the Trenton than to the Chazy. Leaving out of account the Bryozoa, which in the Ordovician nearly always have a very restricted vertical range, and the 5 forms not specifically identified, it is found that 17 of the 25 species remaining are Black River or Trenton forms. All the brachiopods, 4 of the 5 gastropods, and 2 of the 3 trilobites are species occurring in higher formations. Even if all the described species are included, 53 per cent of the species of the Lebanon formation are Black River or Trenton forms.

Below the Lebanon is the Ridley horizon, about 80 feet in thickness. Of the 9 species listed from this formation, 6 are found in the Black River.

Below the Ridley is the Pierce limestone with 12 species listed and 20 undescribed bryozoans. Only 11 forms are specifically identified and of these 30 per cent are Black River or Trenton forms.

The lowest member of the Stones River group is the Murfreesboro, which is about 60 feet in thickness and contains 24 species, 21 of which are identified. The fauna is composed principally of Mollusca, of which gastropods of the genera *Lophospira* and *Liospira* are particularly numerous. Of the 21 species, 11 are Black River or Trenton forms, so that 52 per cent of the species in this oldest member of the Stones River group belong to the Black River or Trenton.

This analysis may be tabulated thus :—

	Lebanon.	Ridley.	Pierce.	Murfreesboro.	Black River.	Trenton.
Lebanon	25	--	1	--	4	7
Ridley	1	3	--	--	1	1
Pierce	4	2	9	1	1	2
Murfreesboro	3	4	1	21	4	7

Of the 58 described species occurring in these 4 subdivisions of the Stones River, the above table shows that 27, that is, 46 per cent, occur in the Black River and Trenton formations.

Comparing the large percentage of forms common to the Stones River and to the Black River and Trenton with the low percentage—less than 5 per cent—of forms common to the Chazy and Trenton, it becomes evident that the Stones River and Trenton are faunally much more closely connected than are the Chazy and Trenton. This close relationship of the fauna of the Stones River to that of the Trenton, coupled with the stratigraphy, suggests that the whole Stones River is younger than the Chazy.

East Tennessee.

In east Tennessee the Maclurea limestone was correlated by Safford[*] with the Chazy or Black River of New York and Canada. While a large part of this limestone seems to be of Trenton age, a section around Lenoirs has afforded the writer a small fauna containing fossils characteristic of Division 2 in the Lake Champlain region. This region needs further study before definite correlations are made.

DESCRIPTION OF NEW SPECIES.

BRACHIOPODA.

Lingula columba sp. nov.

Shell small, oval in outline, gently and uniformly convex. There are no flat slopes and the front is semi-circular in outline. The posterior end is somewhat triangular, the beaks pointed. The surface is covered by very numerous and prominent concentric striæ, no radiating lines showing except when the surface is exfoliated.

One specimen is 10^{mm} long and 7^{mm} wide; another is 7^{mm} long and 5^{mm} wide.

Locality.—East side of Valcour Island at Chazy, and on Isle La Motte. Type in Yale University Museum.

Camarotœchia pristina sp. nov.

Shells small, transversely oval to subcircular in outline. Both valves moderately and uniformly convex. The dorsal valve has a low fold and the ventral valve a shallow sinus, which is noticeable only toward the front of the shell. There are 10 to 14 strong rounded plications, 4 on the dorsal fold and 3 on the sinus. The 2 plications in the middle of the fold are smaller than the 2 outside ones and the median plication of the ventral valve is the weakest, which is the direct opposite of the state found in *Camarotœchia orientalis*.

Locality.—Valcour Island and Chazy, New York. The type is in the Carnegie Museum.

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[*] Geol. Tennessee, 1869, p. 236.

Camarotœchia major sp. nov.

Outline somewhat oval, widest a little in front of the middle. Dorsal valve with 10 to 14 strong angular plications. The ventral valve has 9 to 14. The fold and sinus are hardly defined except by a gentle arch in front, but are outlined on both valves by a pair of very strong plications. The dorsal fold bears 5 plications, the middle one of which is the strongest. The ventral sinus has 4 plications, the 2 largest in the middle. The ventral beak is somewhat incurved.

Length of a good specimen 23^{mm}; width 21^{mm}.

Locality.—Southeast point of Valcour Island, New York. The type is in the writer's collection.

Strophomena prisca sp. nov.

Shell of medium size, resupinate, nearly as long as wide. Ventral valve convex at the umbo, flat in front to about the middle of the valve and then concave. Dorsal valve flat on the umbo and convex in front. Cardinal area narrow, the wide delthyrium mostly covered by the deltidium, with a small opening for the pedicle at the beak. Muscle area in the ventral valve small, confined to the space under the umbo. Surface marked by fine alternating striæ, the prominent ones being very numerous and increasing by implantation. Between each pair of the strong striæ are two or three finer ones and the whole surface is crenulated by fine concentric striæ. The dorsal valve sometimes shows very small concentric wrinkles.

One specimen is 15·5^{mm} long and 20^{mm} wide; another 16^{mm} long and 19·5^{mm} wide.

Locality.—All the specimens are from Valcour Island, New York, and are in the writer's collection.

Orthis ignicula sp. nov.

Shell transversely oval in outline, usually but little wider than long. Hinge width nearly equal to the greatest width of the shell. Ventral valve strongly convex, the area high and a little incurved.

Dorsal valve nearly flat, with a broad depression near the front. Area of dorsal valve rather wide. Cardinal process small. Delthyrium narrow and open. Surface marked by 16 to 25 direct rounded plications which increase by implantation.

Locality.—Found rarely on the southeast corner of Valcour Island, New York.

Orthis acutiplicata sp. nov.

Shell small, almost circular in outline. Hinge width not quite equal to the greatest width below. Cardinal area of ventral valve high and a little retrorse. Foramen narrow and open. Ventral valve strongly convex, highest on the umbo. Dorsal valve convex on the umbo, flattened in front. There is a shallow sinus on this valve, which is narrow at the beak but becomes wider in front. Surface marked by 12 to 15 sharp simple striæ separated by spaces wider than the striæ.

Locality.—South end of Valcour Island. The types are in the writer's collection.

Plœsiomys strophomenoides sp. nov.

Shell small, ventral valve convex at the umbo, concave in front. Dorsal valve convex, with a narrow sinus on the umbo, but frequently with a slight fold on the front of the shell, in which case the ventral valve shows a shallow median sinus.

Surface marked by numerous fine striæ, which increase by bifurcation and implantation. There are usually 7 or 8 in the space of 2 millimeters on the middle of the front of the shell.

The cardinal area of both valves is low. The ventral area has a narrow delthyrium, which at the apex is perforated for the passage of the pedicle. The interior of the ventral valve shows small but strongly marked muscle scars under the umbo. The muscle area is roughly quadrate and contains a pair of strong diductor scars, between which are the narrow adductor attachments. Posterior to the latter is a deep pedicle scar. The lateral edges of the diductor scars are bounded by strong plates, which run back to support the dental lamellæ. The interior of the dorsal valve shows a robust, simple cardinal process and small dental sockets bordered by strong plates which do not greatly diverge. In front of the cardinal process is a low but strong median ridge, on either side of which are the four scars of the adductor, not, however, deeply impressed.

Locality.—Crown Point, Plattsburg, and Valcour Island, New York. The type is from the quarries near the Plattsburg Fair Grounds and is in the Carnegie Museum.

Hebertella exfoliata sp. nov.

This shell is distinguished from *Hebertella costalis* by its smaller size, more pronounced dorsal sinus, and by the fact that the striæ are always simple instead of bifurcating. It differs from *H. borealis* in its smaller size, and in the narrow and deep dorsal sinus.

Locality.—Common in the lower part of the Chazy at Chazy and Valcour Island; also at Plattsburg, Valcour, and Isle La Motte, New York. The type is in the Carnegie Museum.

Orthidium lamellosa sp. nov.

Ventral valve strongly convex, the area high and curved backward. Delthyrium narrow and open. Along the middle of the valve is a narrow and shallow depression in which there is one plication. The outline of the shell is subquadrate. The greatest length is at the hinge and the cardinal extremities are slightly alate.

The dorsal valve has a narrow median sinus, which extends from the beak to the front and usually contains 2 plications. There are commonly about 20 sharp plications, which are crossed by strong concentric lamellæ of growth.

An average specimen is 3^{mm} long and $5{\cdot}5^{mm}$ wide.

Locality.—Valcour Island, Chazy, and Crown Point, New York. The types are in the Yale University Museum.

PELECYPODA.

Ctenodonta peracuta sp. nov.

Shell small, longer than high, the beak about one-third the length from the posterior margin. Front rather drawn out, as in *Ctenodonta nasuta* Hall. The greatest convexity is at the umbo, the posterior slope very gradual. Both slopes to the hinge abrupt, but that to the basal margin gentle. One specimen is 12^{mm} long and 9^{mm} high. This species may be distinguished from the succeeding one by its more depressed valves and by the prolongation of the anterior margin into a somewhat nasute extension.

Locality.—Found in some numbers in the trilobite layers at Sloop Bay, Valcour Island, and in the middle of the Crown Point section. The type is in the writer's collection.

Ctenodonta limbata sp. nov.

Outline nearly circular, the beak back of the middle. Greatest convexity near the middle of the valve; all slopes steep. The cast shows a few faint lines of growth.

Length of largest specimen 10^{mm}; height 10^{mm}. A smaller one measures 8 x 8^{mm}.

Locality.—All the specimens are from the trilobite layers, Sloop Bay, Valcour Island. The types are in the Yale University Museum.

Ctenodonta dubiaformis sp. nov.

Shell small, moderately convex, beak subcentral. Greatest convexity on the umbo, the slope from it to the base nearly flat. Basal margin nearly straight. Anterior end nasute and longer than the posterior, which is regularly rounded. Front margin rather acute. All the specimens are of casts without trace of hinge teeth, muscle scars, or surface markings.

Largest specimen: Length 19^{mm}; height 10·5^{mm}. Another: Length 17^{mm}; height 9^{mm}.

Locality.—Sloop Bay, Valcour Island. The type is in the Yale University Museum.

Ctenodonta parvidens sp. nov.

Shell oval in outline, usually flattened, but specimens from the harder layers show considerable convexity below the umbo, with regular slopes to the anterior, posterior, and ventral margins. The cast shows the impression of numerous very fine teeth on the hinge, but the number can not be counted as the beak is always flattened down upon the impression of the hinge. One specimen exhibits 5 teeth on the anterior portion of the hinge. Another shows 7. The surface is marked by very numerous fine concentric lines of growth.

Locality.—In shales and limy clays at the Hog's Back, Ottawa.

Clidophorus obscurus sp. nov.

Shell small, longer than high, not very convex. Basal margin nearly straight, anterior margin regularly curved, posterior end compressed, the margin acutely rounded. In front of the beak the cast shows a short clavicular impression, which extends about half the distance to the lower margin.

Length 6^{mm}; height 4^{mm}.

Locality.—Trilobite layers, Sloop Bay, Valcour Island. The type is in the Yale collection.

Cyrtodonta tranceps sp. nov.

Shell roughly rectangular in outline, strongly convex at the umbo and along a ridge which runs diagonally across the shell to the lower side of the posterior margin. In front of this ridge there is usually a slight depression running from the umbo to the middle of the lower side. The posterior margin is regularly rounded, the lower side straight or slightly indented. The anterior end extends a short distance in front of the beak. The slope to the hinge is flat and rather steep. The slope to the front and base is gently convex and more gradual. The surface is marked by numerous concentric lines.

Locality.—Valcour Island, New York. The type is in the collection of the Carnegie Museum.

Cyrtodonta solitaria sp. nov.

Shell roughly triangular, the beak a little behind the anterior end. Hinge line short. The anterior margin is narrow and rounded, the base long and straight, incurved at about 45° with the hinge. Posterior regularly rounded. Shell only moderately convex, the slope to the posterior end gradual and to the front nearly flat.

Length 15^{mm}; height $12{\cdot}5^{mm}$. Surface marked by concentric lines of growth.

Locality.—Ledge in pasture near Tracy Brook, Chazy, New York. The type is in the Yale collection.

Whitella canadensis sp. nov.

Shell small, convex, subrectangular in outline. A prominent ridge extends from the beak to the lower posterior corner. From this ridge the slope to the cardinal and posterior margins is abrupt, while there is little slope to the front until a point in front of the beak is reached, when the slope is suddenly deflected. The surface is marked by concentric undulations.

Locality.—Aylmer sandstone, Aylmer, Quebec.

Clionychia marginalis sp. nov.

Both valves moderately convex, the umbones somewhat depressed, but increasing rapidly in height, the greatest thickness of the valves being at about one-third the distance from the beak to the lower margin. Hinge line short. The posterior margin is broadly rounded, the lower margin semi-circular. The front is almost straight. The greatest convexity is along a line parallel to the front. The posterior and lower slopes are gentle, but the front slope is abrupt, almost 90° with the plane of union of the valves. The surface is marked by very fine concentric striæ.

One specimen is 20^{mm} long and $26{\cdot}5^{mm}$ high.

Locality.—Chazy and Valcour Island, New York. The type is in the Yale collection.

Ambonychia? curvata sp. nov.

Shell large, both valves very strongly convex, especially along the region of the front and middle of the valves. Beaks small, incurved, directed a little forward. Anterior slope abrupt and overhanging. Posterior and bottom slopes rather steep. Posterior wing short. The posterior margin is almost straight. The anterior margin is regularly curved. The length and breadth are nearly equal.

A large specimen is 27^{mm} long and 26^{mm} high. Another is 43^{mm} long and 39^{mm} high. A small one is 10^{mm} long and 10^{mm} high.

The species is easily recognized by the curved anterior margin and the great convexity. The line of greatest convexity follows the anterior margin. There is an elongate posterior muscle faintly outlined on some of the casts. The general appearance is somewhat like *Ambonychia amygdalina* Hall.

Locality.—Valcour Island, Chazy, and Sloop Island, New York.

Conocardium beecheri sp. nov.

Shell very small but robust, with long anterior and short posterior wings. The region of greatest convexity is from the beak straight to the base of the shell, the curvature decreasing gradually forward to the anterior wing and rather abruptly backward to the posterior wing. The anterior wing is long, with straight lower margin. The posterior wing is short and narrow, joining the body at a large angle. The surface is marked by 7 or 8 large plications on the anterior wing, 15 or 20 smaller ones on the body of the shell, and 3 or 4 very large ones on the posterior wing. The dimensions of 2 specimens are: First, length $6{\cdot}5^{mm}$, height 5^{mm}; second, length 6^{mm}, height 4^{mm}.

Locality.—Sloop Island, east of Valcour Island, New York; also on Valcour Island and at Chazy, Clinton County, New York.

Modiolopsis fabaformis sp. nov.

Shell small, thick, with a strong ridge extending from the umbo to the lower posterior angle. In front of this ridge is a deep depression, which continues to the middle of the ventral margin, making that margin sinuate. Anterior ear small, convex. Anterior margin narrowly rounded. Posterior margin broadly rounded, not oblique as in *Modiolopsis breviuscula* and *M. parviuscula*. The surface is marked by numerous concentric lines of growth.

Locality.—Common in the upper layers at Valcour Island. The type specimen is in the writer's collection.

Modiolopsis sowteri sp. nov.

Shell of medium size for the genus, rather convex, with a strong ridge running back from the beak to the lower posterior angle. Toward the front is a slight depression running from just ahead of the beaks a little backward to the basal margin. In front of the beak is a very deeply impressed anterior scar, which on the internal cast is represented by a rounded conical elevation. The posterior scar is large and close to the hinge line.

Length 51mm, height 28mm.

Length 37mm, height 20mm.

Locality.—From the Aylmer sandstone, about 60 feet above the high-water mark of Lake Deschenes, at Aylmer, Quebec. Collected by T. W. E. Sowter, for whom it is named. The type is in the Yale University Museum.

GASTROPODA.

Archinacella? deformata (Hall).

Orbicula ? deformata Hall, 1847, Pal. N. Y., vol. i, p. 23, pl. iv bis, figs. 10a, 10b.

Metoptoma ? dubia Hall, ibid., figs. 11a, 11b.

Stenotheca dubia Whitfield and Hovey, 1898, Catalogue of Type and Figured Specimens in the American Museum of Natural History, Bull. Amer. Mus. Nat. Hist., vol. xi, p. 58.

An examination of the types shows that Whitfield was right in regarding the specimen named *Orbicula? deformata* by Hall as identical with *Metoptoma ? dubia*, which Hall described on the same page. His species, however, must take the first specific name applied to it, even though given under the misapprehension that it was a brachiopod instead of a gastropod. The generic reference is uncertain as no specimens have been found which show either muscle scars or pronounced surface markings. It does not seem possible to leave it either in the genus *Metoptoma*, where Hall doubtfully put it, or in *Stenotheca*, where it was placed by Whitfield. In general form it most resembles the numerous species of *Archinacella* described by Ulrich and Scofield, to which it may be referred until better examples are obtained. The individual specimens of this shell are abundant and the characters are quite constant. It is easily recognized by the low form and almost marginal position of the beak.

Scenella pretensa sp. nov.

Shell small, aperture narrowly elliptical in outline. Height about equal to the greatest diameter of the aperture. Beak small, pointed backward, but not incurved. Posterior slope nearly straight. Anterior slope convex above, becoming straight below. Surface smooth, except for a few low concentric undulations near the base. Beak a little behind the middle.

The greatest diameter is 11mm; the shortest is 6·5mm. Height 11·5mm.

Locality.—Rare at Chazy, New York, in the Lower Chazy layers south of the lime kilns. It occurs also at Lenoirs, Tennessee.

Scenella robusta sp. nov.

Shell large, aperture nearly circular. Beak obtuse, rather high, and located a little behind the middle. All slopes about equal and all convex, the whole shell somewhat hemispheric. The specimens are all casts, showing no surface markings of any sort.

The only perfect example is 17^{mm} in greater diameter and 16^{mm} in lesser. A much larger one is represented by a fragment 27^{mm} long, but it had evidently been considerably larger.

Locality.—Valcour Island, in the Middle Chazy beds. Rare. The type is in the writer's collection.

Palæacmæa irregularis sp. nov.

Shell rather large, irregular in outline, generally subcircular, but never with a smooth curve. Beak obtuse, almost central, sometimes a little back of the center. All slopes about equal, generally almost straight, but occasionally a little convex. Surface marked by numerous fine concentric lines of growth, which follow the irregular form of the aperture. Usually there are a few radial folds and some irregular depressions and pits which do not follow in symmetrical arrangement.

The greater diameter of the aperture is 26^{mm}; the lesser is 10^{mm}. The aperture of another is 19^{mm} long, 18^{mm} wide, and the apex is 9^{mm} above the aperture.

Locality.—Common in lower layers at Chazy, New York.

Helicotoma vagrans sp. nov.

Shell small, somewhat *Maclurea*-like, the spire flat and depressed below the plane of the highest points on the upper surface. Outer edge of the body whorl angular, raised as a high sharp ridge toward the aperture. Lower surface of the shell rounded, the umbilicus wide. Aperture large, quadrilateral, angular above, rounded below. Surface marked by fine lines of growth, which turn back on crossing the angle of the upper surface.

Locality.—A rare fossil at Valcour Island, New York. The type is in the writer's collection.

Eotomaria obsoletum sp. nov.

Shell small, trochiform, with about four volutions. The upper part is conical, the volutions are flat, and the sutures only slightly impressed. The lower surface is convex, umbilicus small. The present specimen is a cast and shows no surface markings. Aperture large, angulated on the side, rounded below.

Locality.—Crown Point and Valcour Island, New York. Very rare. The type is in the writer's collection.

Lophospira rectangularis sp. nov.

Shell fairly large, with 5 volutions. Body whorl very large, spire small. Last 3 whorls with sides parallel to the axis of the shell. Aperture large, nearly circular. Upper lip nearly straight, meeting the straight outer lip at an obtuse angle. The inner and lower sides of the aperture are rounded. The umbilicus is very small.

All the specimens in the collection are casts of the interior and do not show anything more than traces of the surface markings. They were probably the same as in *Lophospira subabbreviata.*

Locality.—A rare species from Valcour Island, New York. The type is in the writer's collection.

Lophospira billingsi sp. nov.

Shell of 4 volutions, body whorl very large, spire low, whorls angular, sloping gently from the suture to the keel. The under side of the body whorl is rounded and strongly convex. The umbilicus is small. The aperture is entire, the inner and lower lips are rounded, the upper lip is straight from the suture to the keel, sharply angulated at the keel and nearly straight for a short distance below it. The surface is covered by rather coarse lines of growth, which run first forward and cross the upper side of the volution diagonally and backward, again turning forward after crossing the volution. On the under surface of the whorl, the striæ turn back to the umbilicus.

Locality.—From the Canadian Pacific Railroad cut, east of Main street, Aylmer, Canada. Named for W. R. Billings of Ottawa, an enthusiastic student of the Chazy.

Cyclonema? normaliana sp. nov.

Shell small, elongate trochiform, with 4 or 5 whorls, which enlarge gradually. Sutures not deeply impressed and volutions almost flat sided. The under surface of the last whorl is flat or slightly convex. The surface is marked by 3 or 4 revolving raised lines or low keels.

Locality.—Lower Chazy, near the Normal School at Plattsburg, New York.

Eunema leptonotum sp. nov.

Shell small, with about 4 whorls, which increase gradually toward the base. The whorls are all convex, the suture is deeply impressed. The first 3 whorls are smooth and *Holopea*-like. The fourth, or body, whorl is ornamented by 5 sharp revolving ridges, equally spaced. These ridges are crossed by fine vertical lines, which are close together and give the ridges a pitted appearance. The aperture is not seen.

The height of the shell is 5^{mm}; the width of the body whorl $3{\cdot}5^{mm}$.

This shell is not uncommon in the Chazy, but on account of its small size and liability to exfoliation it is often overlooked or is in too imperfect a condition to be positively identified.

Locality.—Lower Chazy, at Chazy, New York. The type is in the Yale collection.

Trochonema dispar sp. nov.

Shell rather large, consisting of 3 whorls with depressed spire and very large body whorl. The suture is very deep. The whorls are almost free. The body whorl has a flat revolving band on the outer side. The top is flat and sloping and the lower side strongly convex. The surface markings are not shown. The umbilicus is large in the cast, but rather small in testiferous specimens.

Locality.—Fairly common on Valcour Island, in a locality at the south end. It is rare elsewhere on the island and at Chazy, New York. The type is in the writer's collection.

Subulites prolongata sp. nov.

Shell small, elongate, fusiform, with about 6 (?) whorls (specimen shows body whorl and 3 above). The whorls are long and narrow, decreasing slowly and regularly toward the top. The body whorl is about equal to the length of the 2 whorls above it and is contracted below. The aperture is not shown.

The length of the fragment is 29^{mm}; the greatest thickness is 5^{mm}. Probably the total length was about 35^{mm}.

Locality.—Sloop Bay, Valcour Island. The type is in the Yale collection.

Holopea hudsoni sp. nov.

Shell usually large, with about 4 whorls. The body whorl is large, robust, expanding rapidly. The spire is fairly long, whorls strongly convex, sutures very deep. Aperture nearly circular, entire; the outer lip thin, the inner lip free from the body whorl. The umbilicus is small.

The surface is usually smooth. Some casts show traces of lines parallel to the margin of the outer lip. These lines run a little forward from the suture, continuing in this direction over the bulge of the whorl, then curve a little backward and finally forward again at the lower end.

Locality.—Rather common at Crown Point, Valcour, Valcour Island, Plattsburg, and Chazy, New York. The type is in the writer's collection.

Holopea scrutator sp. nov.

Shell of medium size, about 3 whorls, the body whorl constituting by far the larger part of the shell. Spire depressed, sutures not deep. Aperture elongate, oval, entire. Umbilicus small.

The specimens usually occur as casts, but on a few the shell is preserved. It shows no markings except a few growth lines, which run diagonally back across the whorl. When the specimens are exfoliated the suture lines are much more deeply impressed and the spire appears higher.

This shell is easily distinguished from the preceding by the low spire, the shallowness of the sutures and the general depressed form of the shell.

Locality.—Common at Valcour Island and Chazy, New York. The type is in the Yale Collection.

Conularia triangulata sp. nov.

Shell small, slender, slightly curved, 6-sided, but 3 of the sides are so narrow as to give the shell an almost triangular cross section. The narrow faces alternate with the wide ones, the former truncating the angles which the latter would make if prolonged till they met. Along each of the faces, both wide and narrow, is an elevated line, which extends longitudinally along the center of the face. The surface markings consist of numerous fine tranverse striæ, which bend backward on crossing the raised line.

The best specimen in the writer's collection is broken at the tip and at the aperture, yet is 38^{mm} long. The original length was at least 8^{mm} more. At the largest end the 3 wide faces are each 7^{mm} wide and the narrow faces are each $1·5^{mm}$ wide. At the small end the wide faces are $2·5^{mm}$ wide and the narrow faces are reduced to practically nothing, thus showing that in young stages the shell was really triangular.

Locality.—The type specimen, which is in the writer's collection, was found in the upper part of the Chazy, on the southeast point of Valcour Island (Cystid Point). It also occurs near Smuggler's Bay, in layers a little lower in the formation.

OSTRACODA.

Leperditia limatula sp. nov.

Length 10·5$^{\text{mm}}$; height 7·5$^{\text{mm}}$.
Length 9$^{\text{mm}}$; height 6$^{\text{mm}}$.
Length 9·5$^{\text{mm}}$; height 6.25$^{\text{mm}}$.
Length 9.5$^{\text{mm}}$; height 7·5$^{\text{mm}}$.

Shell of medium size, a little smaller than *Leperditia fabulites*, oblong in outline, higher behind than in front. Hinge short, straight. Anterior end regularly rounded. The posterior end slopes back almost straight for a short distance, but is broadly rounded on the lower posterior margin. The eye tubercle is small, on some specimens sharp, on others obscure. It is situated in the anterior angle, above and a little in front of the "muscle spot." The latter is large, circular, and very finely reticulated. Back of the muscle spot is a region of the shell which is covered with fine raised lines radiating from the side of the spot. These lines frequently anastomose, making a very pretty reticulate surface. The muscle spot is raised above the general surface of the carapace on the lower posterior side, where these lines originate, but the upper and anterior sides are level with the main part of the shell.

The right valve overlaps the left valve considerably, especially along the ventral edge, which is abruptly deflected and usually shows a low short ridge right at the keel. The lower margins of the anterior and posterior ends are flanged. The border is very narrow and is marked by small pits, which increase in size ventrally. On one finely preserved specimen the anterior flange shows 8 pits, of which the seventh, counted from the front, is largest, and the eighth is very small. On the posterior flange of the same specimen there are 10 pits, the eighth from the posterior end being the largest, the ninth a little smaller, and the tenth minute. The left valve is not so high in proportion to the length as the right valve, but it is also abruptly deflected ventrally. It shows neither anterior nor posterior flanges and there is a small projection close to the hinge line and parallel to it. Below this is a slight depression.

Locality.—Common on Valcour Island in certain localities. Rare at Valcour and Chazy, New York.

Primitia latimarginata sp. nov.

Carapace small and depressed. Front and posterior margins meet the dorsal margin at angles of little more than 90°. Both ends are broadly rounded, the ventral margin is gently curved. The shell is a little higher at the posterior end than in front. There is a deep sulcus just in front of the middle, which starts from the dorsal margin and extends half-way down the valve, turning a little forward at the lower end. On well-preserved specimens, in front of this sulcus there is a prominent eye spot, which is sometimes translucent. Often there is another slight depression or sulcus in front of the eye spot. The border is wide, concave, and of nearly uniform width all around from the anterior angle of the dorsal margin to the posterior one. The test is frequently punctate.

Locality.—Common all through the Chazy limestone at Chazy, Valcour Island, Crown Point, and elsewhere in the Champlain Valley.

TRILOBITA.

Heliomera subgen. nov.

Heliomera sol (Billings).

Cheirurus sol Billings, 1865, Paleozoic Fossils of Canada, vol. i, p. 288, fig. 276.

Cephalon short, wide, the glabella very large and flattened, the cheeks small. Glabella almost semi-circular, with 3 pairs of long, narrow glabellar furrows, all of which turn backward on their inner ends, each joining the one back of it, and the third pair joining the neck furrow, thus producing a central lobe like that of *Amphilichas.* This central lobe is of uniform width up to the inner ends of the first pair of glabellar furrows, but turns outward in front of that point. Toward the front of this median lobe there is a slight depression, somewhat similar to that sometimes seen in *Pliomerops canadensis.* The first pair of glabellar furrows run backward at an angle of about 45°, the second pair at a smaller angle, while the third pair are nearly parallel to the neck furrow. The glabellar lobes are narrow and club-shaped. This radiating arrangement of the glabellar furrows and lobes probably suggested the specific name. The neck ring is wide, flat, and separated from the glabella by a deep furrow, which extends the whole width of the cephalon. The cheeks are not sufficiently well preserved to be described, but enough of the test remains to show that the outline of the cephalon was the same as in *Pseudosphærexochus vulcanus.* There is a narrow smooth border all around the front of the cephalon, and the surface is covered with fine tubercles. The relations of this species are rather doubtful. From the form of the cephalon it evidently belongs close to *Pseudosphærexochus*, but there has not been seen in species of that genus any tendency to vary in the direction of an isolated central lobe and long isolated glabellar furrows. The glabellar furrows in the various species of *Pseudosphærexochus* are usually faint, never deeply impressed as in this species. In this last character and in the presence of the median depression of the glabella, it recalls *Pliomerops.* The glabella is much larger in proportion to the size of the cephalon in *Heliomera sol*, however, and it is probable that this form must be regarded as intermediate between the two genera. For trilobites with this type of glabellar structure the subgeneric name *Heliomera* is suggested.

Locality.—From the Raphistoma layers in the upper part of the Lower Chazy, at Chazy, New York. The type is in the Yale University Museum.

Paleontological Laboratory,
Yale University Museum, June 24, 1905.